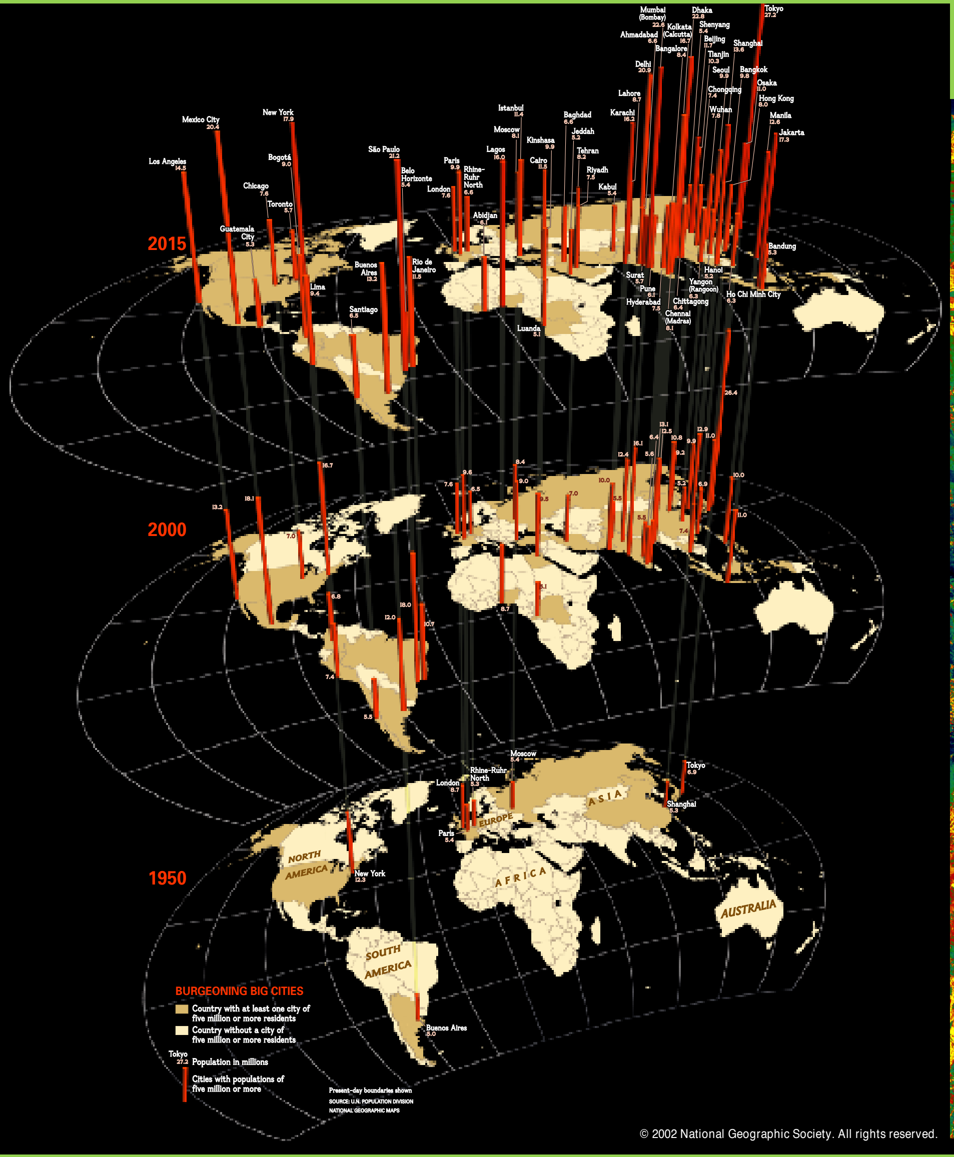
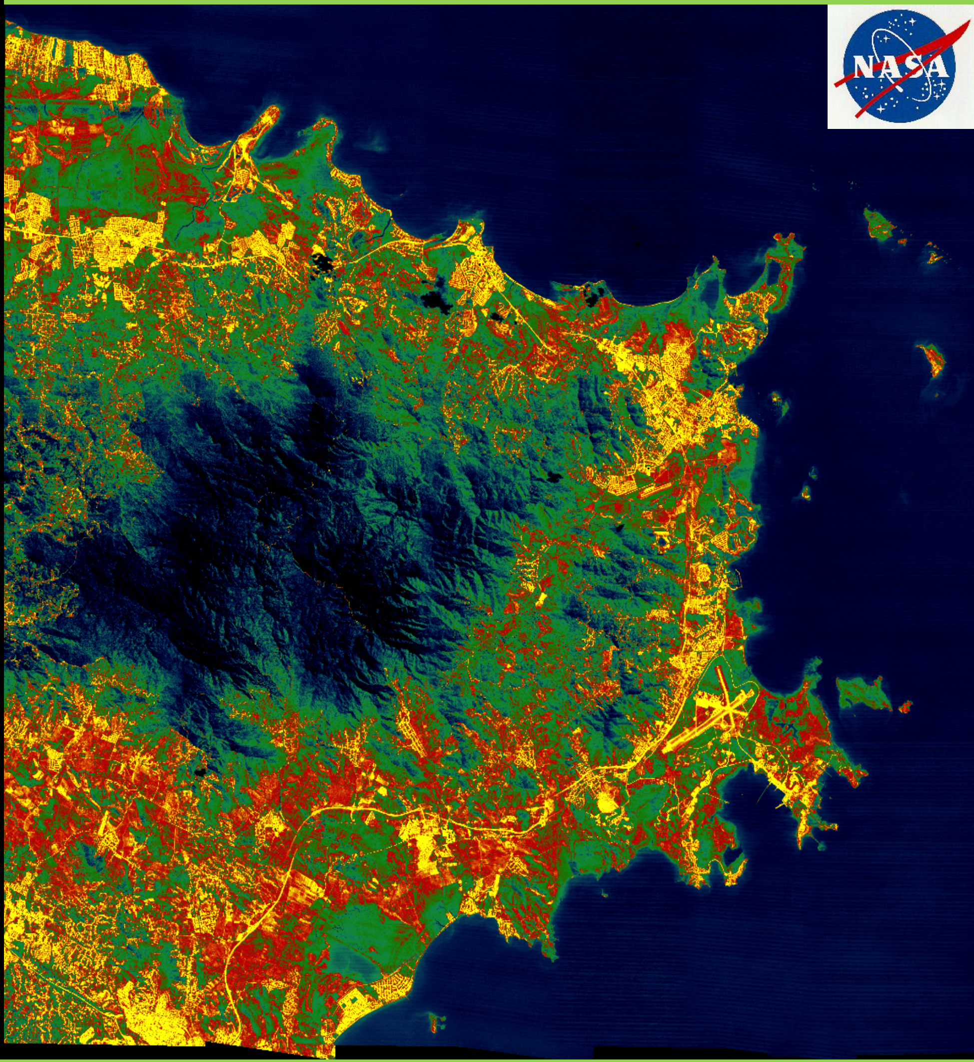
Assessing the Impact of Urbanization Using Remote Sensing On A Global Scale, Past Present And Future Directions





Jeffrey C. Luvall
NASA Marshall Space Flight Center

θΔics

Global Urbanization- A Sense of Scale

- The 21st century is the first “urban century”
- In 2000, approximately 3 billion people (40% of global population) resided in urban areas
- The United Nations estimates that by 2025, 60% of the world’s population will live in cities
- As a consequence, the number of “megacities” – those cities with populations of 10 million or more – will increase to 100 by 2025

HyspIRI TQ4. Urbanization/Human Health

- How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
- How do changes in land cover and land use affect surface energy balance and the sustainability and productivity of natural and human ecosystems?
- What are the dynamics, magnitude, and spatial form of the urban heat island effect (UHI), how does it change from city to city, what are its temporal, diurnal, and nocturnal characteristics, and what are the regional impacts of the UHI on biophysical, climatic, and environmental processes?

•Human Health - heat mortality, vector borne diseases
•Heat and Air Quality
•Urban Heat Island (UHI)
•Land Cover/Land Use change
•Regional climate impacts

Surface Radiation Budget

$$Q^* = (K_{in} + K_{out}) + (L_{in} + L_{out})$$

- Q^* = Net Radiation
- K_{in} = Incoming Solar
- K_{out} = Reflected Solar
- L_{in} = Incoming Longwave
- L_{out} = Emitted Longwave

Surface Energy Budget

$$Q^* = H + LE + G$$

H = Sensible Heat Flux

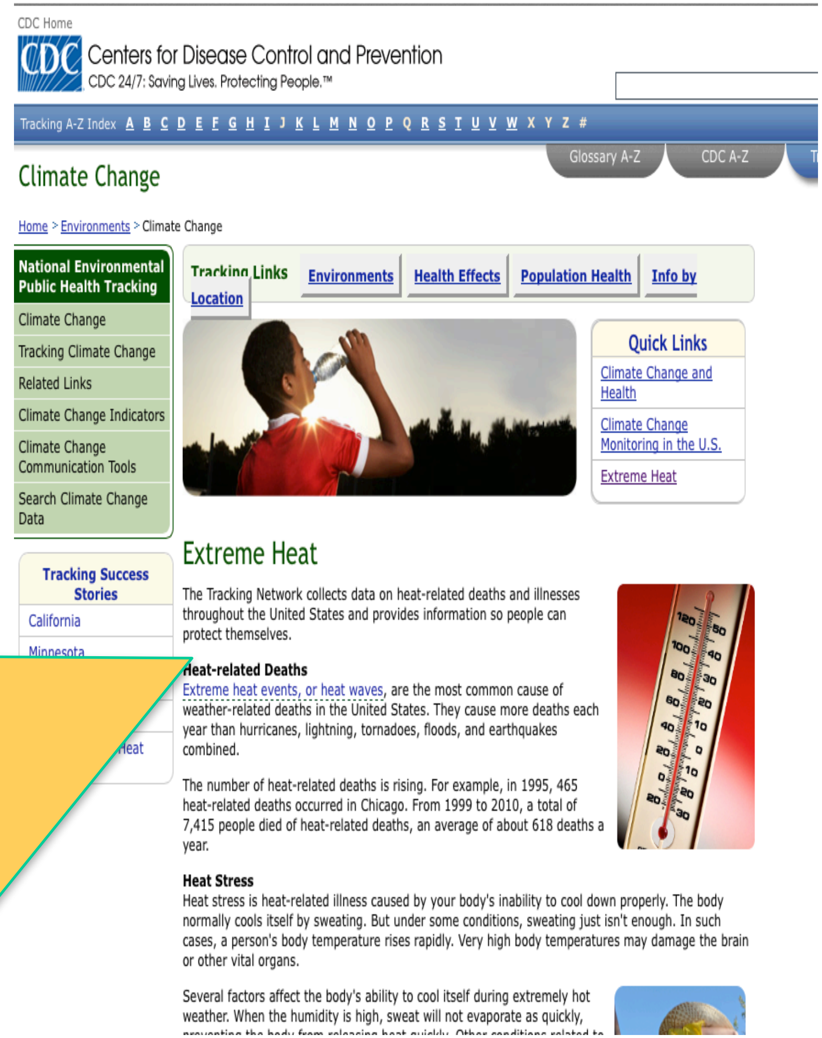
LE = Latent Heat Flux

G = Storage (maybe + or -)

- **European heat wave caused 35,000 deaths 2003**
- **Over 15,000 likely dead in Russian 2010 heat wave; Asian monsoon floods kill hundreds more**
- **Heat wave death toll in NYC rises to 8 NYDN 7/23/13**
- **UK Heat wave death toll: Up to 760 killed and total may double as temperatures above 30^{o} c continue 7/18/13**
- **Chicago July 1995 more than 700 died**

Extreme heat events, or heat waves, are the most common cause of weather-related deaths in the United States. They cause more deaths each year than hurricanes, lightning, tornadoes, floods, and earthquakes combined.

The number of heat-related deaths is rising. For example, in 1995, 465 heat-related deaths occurred in Chicago. From 1999 to 2010, a total of 7,415 people died of heat-related deaths, an average of about 618 deaths a year.


CDC Home

Centers for Disease Control and Prevention

CDC 24/7: Saving Lives. Protecting People.™

Tracking A-Z Index A B C D E F G H I J K L M N O P Q R S T U V W X Y Z #

Glossary A-Z | CDC A-Z

Climate Change

Home > Environments > Climate Change

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- Tracking Climate Change
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- Climate Change Communication Tools
- Search Climate Change Data

Tracking Success Stories
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Tracking Links | Environments | Health Effects | Population Health | Info by Location

Quick Links
- Climate Change and Health
- Climate Change Monitoring in the U.S.
- Extreme Heat

Extreme Heat

The Tracking Network collects data on heat-related deaths and illnesses throughout the United States and provides information so people can protect themselves.

Heat-related Deaths

Extreme heat events, or heat waves, are the most common cause of weather-related deaths in the United States. They cause more deaths each year than hurricanes, lightning, tornadoes, floods, and earthquakes combined.

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Heat Stress

Heat stress is heat-related illness caused by your body's inability to cool down properly. The body normally cools itself by sweating. But under some conditions, sweating just isn't enough. In such cases, a person's body temperature rises rapidly. Very high body temperatures may damage the brain or other vital organs.

Several factors affect the body's ability to cool itself during extremely hot weather. When the humidity is high, sweat will not evaporate as quickly,

Heat Wave Deaths May Triple by the 2050s

By Bahar Gholipour, Staff Writer | February 03, 2014 06:45pm ET

Heat waves can be especially deadly in urban areas.
Credit: Nexus7 | Dreamstime
View full size image

The number of people dying because of heat waves could rise three to four times in some regions by the middle of this century, as a result of climate change and population growth, according to a new U.K. study.

Researchers analyzed the relationship between weather fluctuations and death rates in the past, and projected the results for the decades to come.

They found that by the 2050s, the number of heat-related deaths in England and Wales could surge by 3.5 times its current number, which is around 2,000 deaths yearly in these regions, according to the study published today (Feb. 3) in the Journal of Epidemiology and Community Health. [Top 10 Surprising Results of Global Warming]

International Journal of Low-Carbon Technologies Advance Access published September 5, 2013

Quantification and mitigation of long-term impacts of urbanization and climate change in the tropical coastal city of San Juan, Puerto Rico

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Climate Impacts of Land-Cover and Land-Use Changes in Tropical Islands under Conditions of Global Climate Change

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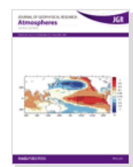
Research Article

Combined impacts of land cover changes and large-scale forcing on Southern California summer daily maximum temperatures

Pedro Sequera, Jorge E. González, Kyle McDonald, Robert Bornstein, Daniel Comarazamy



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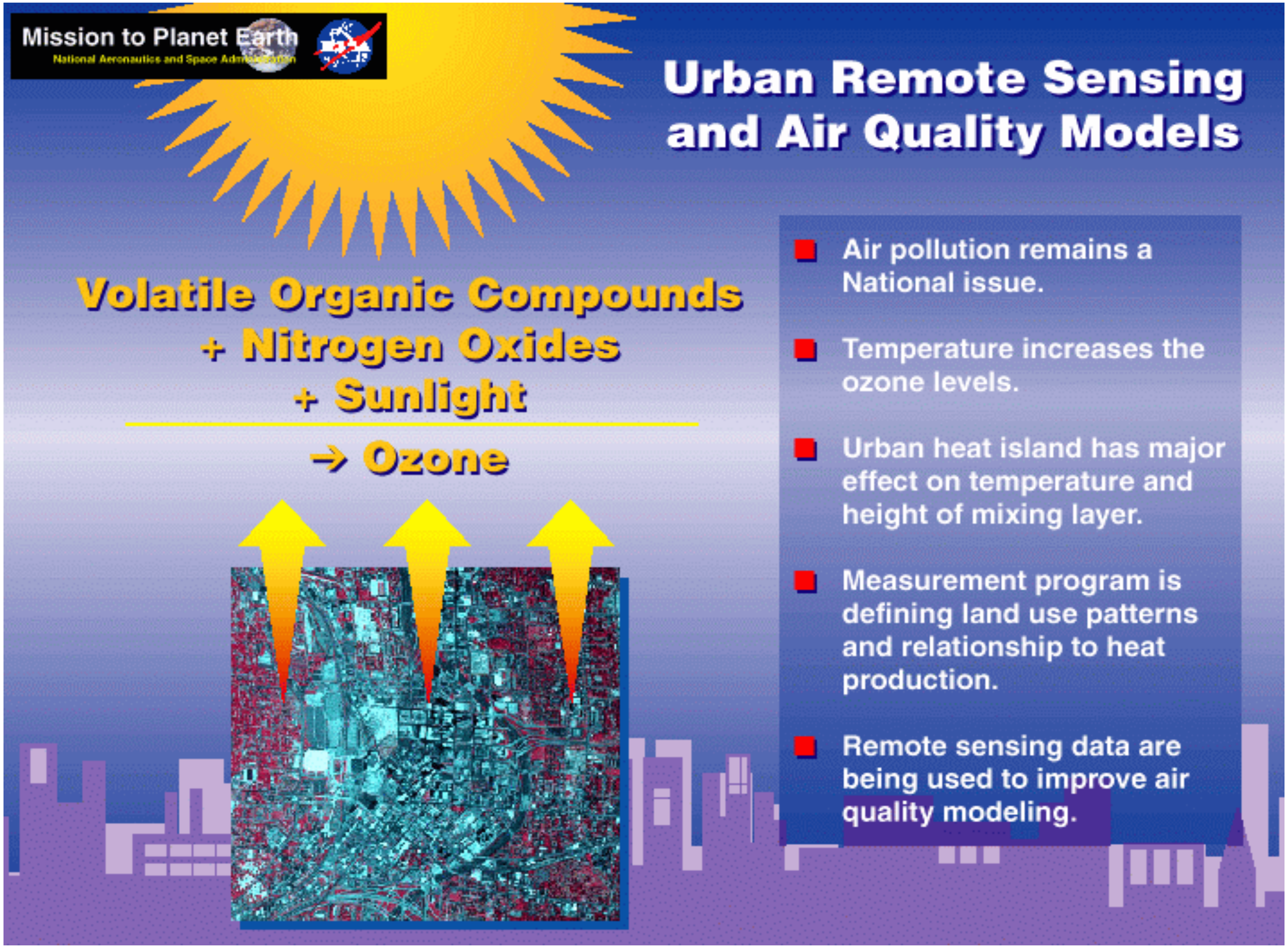
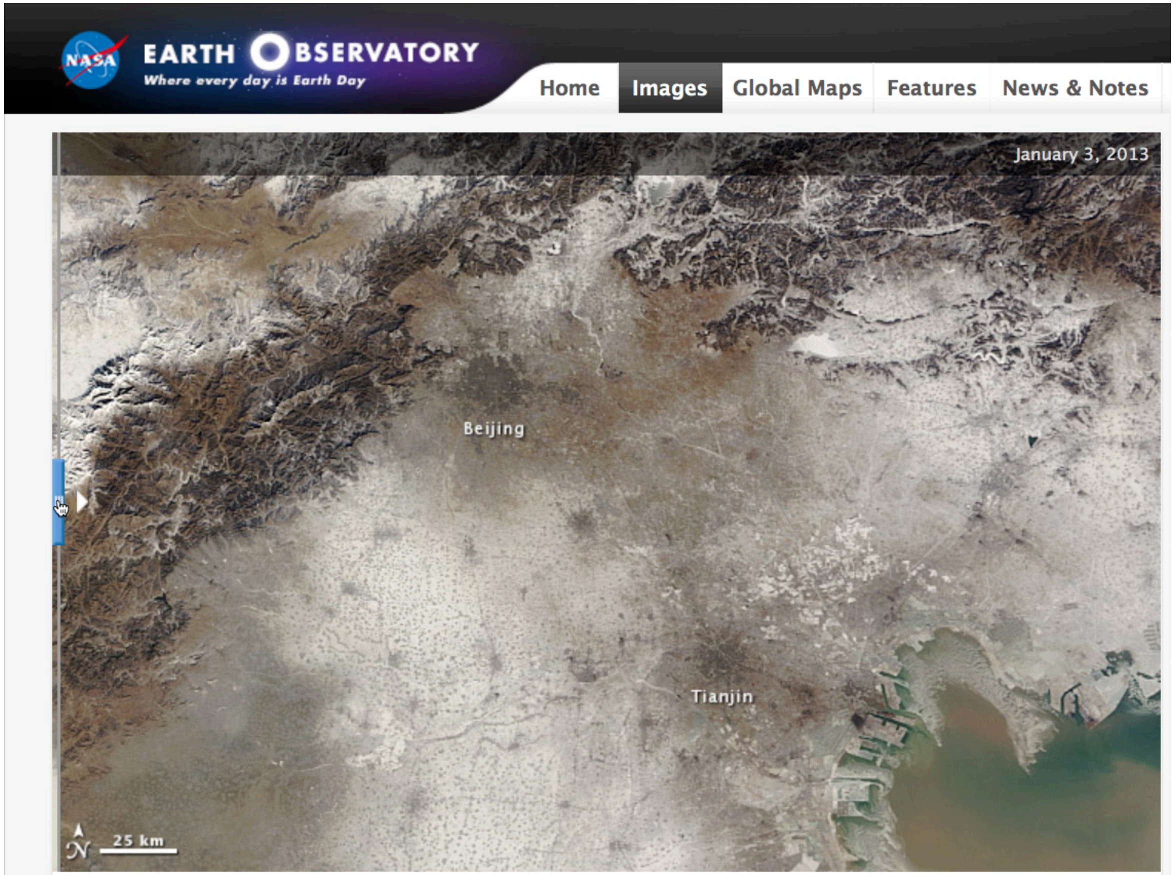

Mission to Planet Earth
Urban Remote Sensing and Air Quality Models
Volatile Organic Compounds
+ Nitrogen Oxides
+ Sunlight
→ Ozone
Air pollution remains a National issue.
Temperature increases the ozone levels.
Urban heat island has major effect on temperature and height of mixing layer.
Measurement program is defining land use patterns and relationship to heat production.
Remote sensing data are being used to improve air quality modeling.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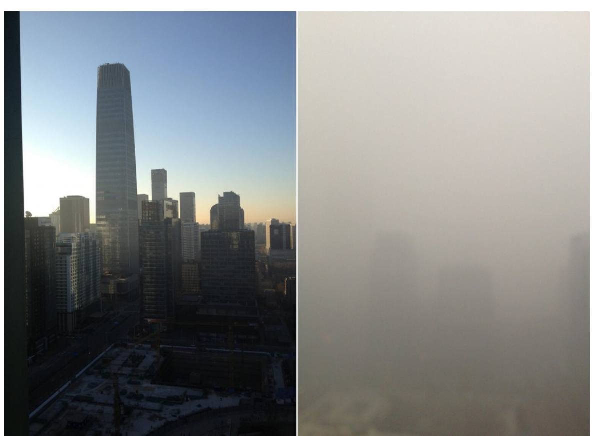


NASA's Project Objectives

- To use high spatial resolution thermal infrared and visible data obtained from aircraft to measure, map, and model the surface energy budget characteristics of surfaces typical of the urban landscape for three US cities.
- Provide these data to EPA for evaluation of the overall "fabric" of the cities in relation to the urban heat island and air quality modeling.
- Transfer NASA technology and research to the public.

NASA's Project Atlanta
~ 1996 - 2001

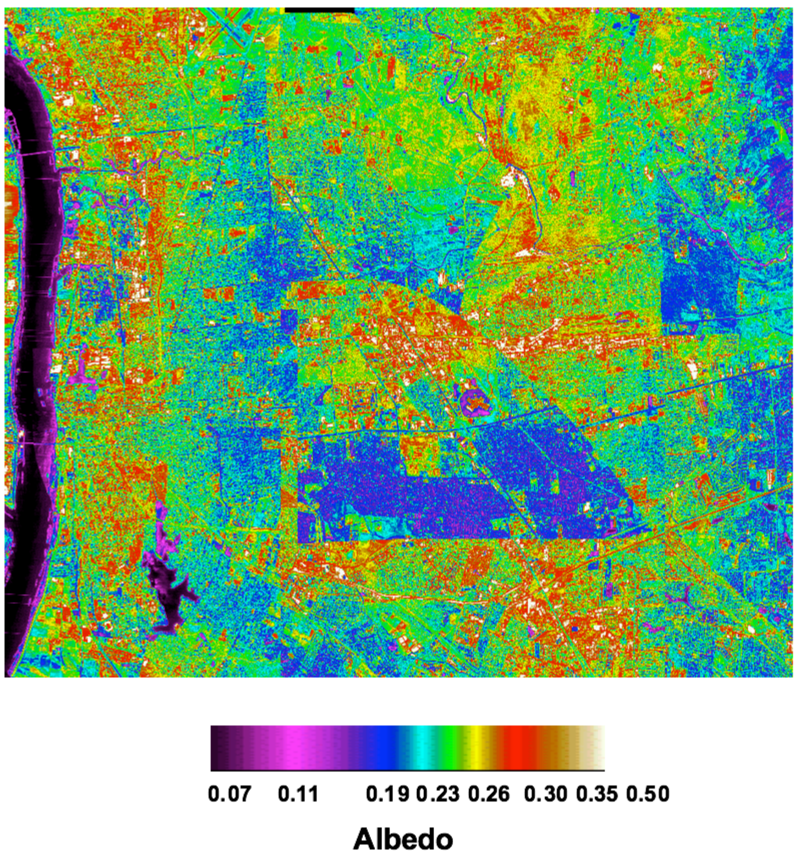
EPA/NASA Urban Heat Island Pilot Project
~ 1997- 2000

NASA EPSCoR San Juan, Puerto Rico UHI
2004

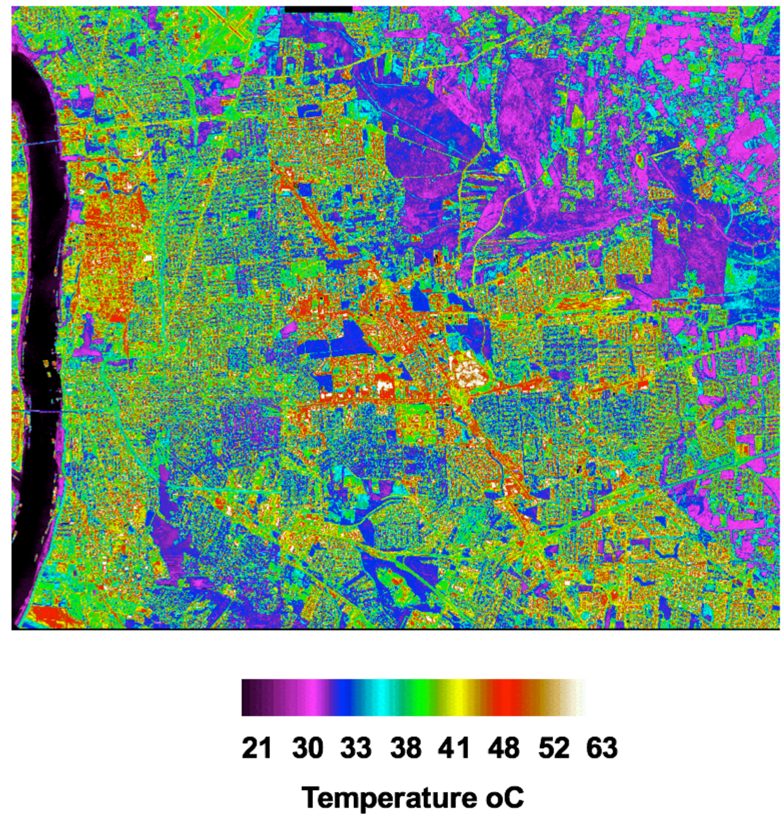
Urban Heat Island Mitigation Strategies

- Albedo Modification
  - Lighter colored roofs and pavements
  - New materials/coatings
- Plant trees and increase green space
  - Shade buildings, rooftops, parking lots and roads
  - Cool the air through transpiration
- Rooftop gardens
  - Keep roofs cool by shading and/or transpiration
  - storm water reduction

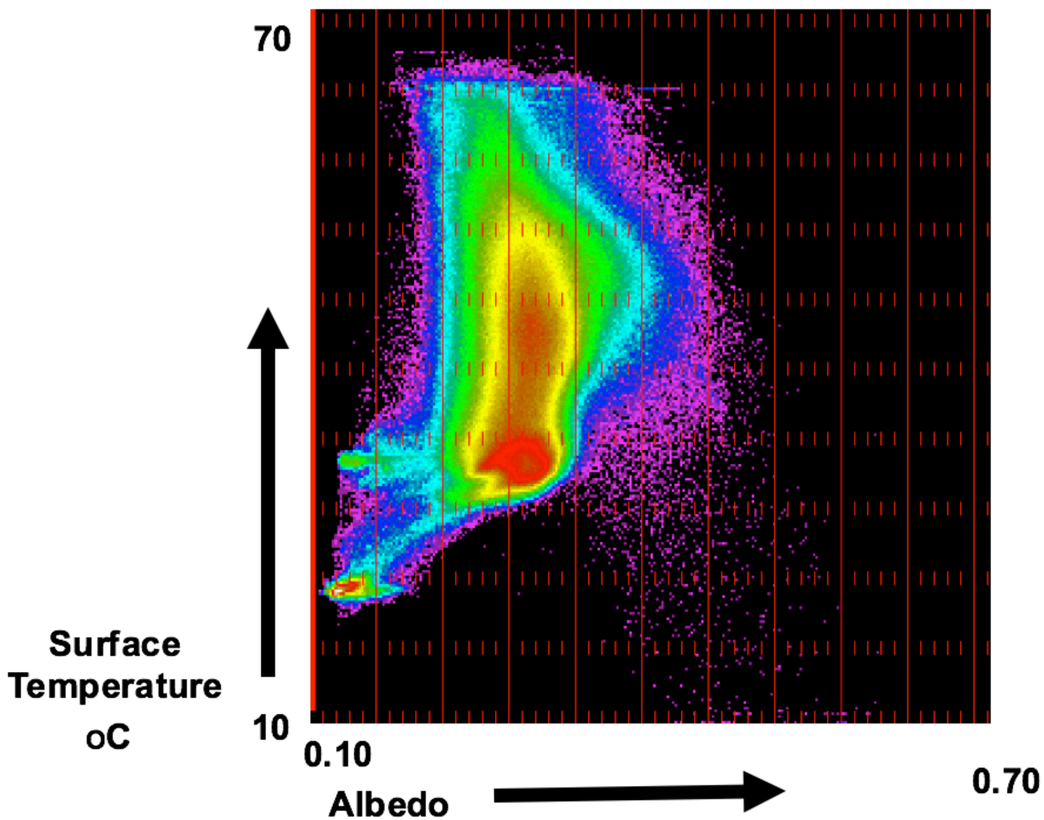
Baton Rouge
Albedo - May 11, 1998



Baton Rouge
Temperature - May 11, 1998



Baton Rouge
Scatter Plots of Albedo vs Temperature



Baton Rouge Scatter Plots
Albedo vs Temperature

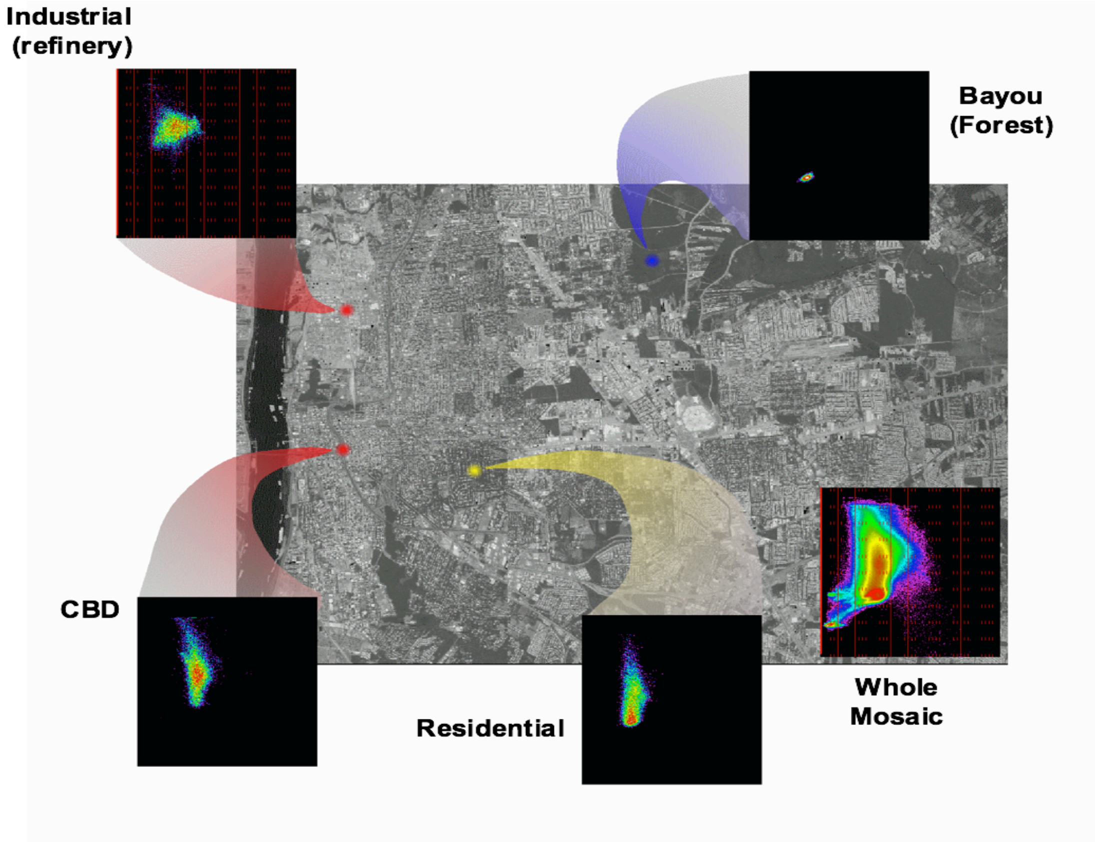


Table 7. Descriptive statistics of dengue cases, environmental and socio-demographic characteristics compared across GND with incidence rate (IR) above and below the median IR	Overall	High IR[%]	Low IR[%]	P-value
Characteristics of dengue cases				
Number of Cases (n)	5379	3096	2283	
Number of Dengue cases by years				**0.0342**
Year 2005	436	245 (7.9)	191 (8.4)	
year 2006	300	156 (5.0)	135 (5.9)	
Year 2007	261	167 (5.4)	102 (4.5)	
Year 2008	314	195 (6.3)	116 (5.1)	
Year 2009	812	479 (15.5)	322 (14.1)	
Year 2010	1269	700 (22.6)	578 (25.3)	
Year 2011	1987	1154 (37.3)	839 (36.8)	
Age (mean, SD)	13.7	14.9 (14.3)	12.1 (12.8)	
Age range (in years)	0.1-89	0.1 -89	0.1 -81	
Age Categories (n, %)				**<0.0001**
0-5	1688 (31.4)	884 (28.6)	804 (35.2)	
5.1 - 9	1222 (22.7)	687 (22.2)	535 (23.4)	
9.1 to 19	1168 (21.7)	643 (20.8)	525 (23.0)	
>19	1302 (24.2)	882 (28.5)	419 (18.4)	
Sex				0.6017
Males	2897 (53.9)	1658 (46.5)	1239 (45.7)	
Females	2482 (46.1)	1438 (53.6)	1044 (54.3)	
Environmental Characteristics				
Buildings (mean, SD)	0.47 (0.07)	0.48	0.45	0.1548
Vegetation	0.22 (0.09)	0.21 (0.09)	0.22(0.08)	0.7117
Roads	0.08 (0.04)	0.12 (0.07)	0.13 (0.05)	0.7304
Shadow	0.13 (0.06)	0.08 (0.04)	0.07 (0.04)	0.4616
Green Space	0.04 (0.04)	0.04 (0.05)	0.04 (0.03)	0.9504
Household Characteristics				
Brick Walls	0.4 (0.1)	0.64 (0.12)	0.54 (0.14)	**0.001**
Cement Walls	0.6 (0.1)	0.31 (0.13)	0.40 (0.13)	**0.0169**
Other wall materials	0.1 (0.1)	0.05 (0.07)	0.06 (0.7)	0.5195
Tile Roofs	0.4 (0.2)	0.36 (0.13)	0.36 (0.13)	**0.0244**
Asbestos Roof	0.5 (0.1)	0.52 (0.13)	0.55 (0.09)	0.3901
Other wall materials	0.1 (0.1)	0.04 (0.06)	0.08 (0.08)	0.0294
Population Characteristics				
Population density (per 1000 sq meters)	20 (12.7)	18 (13)	24 (11)	0.06
Housing density	4.2 (2.5)	347 (258)	494 (223)	**0.0277**

Meghan Tipre 2014 PhD, UAB

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